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## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

<b>(51) International Patent Classification <sup>7</sup>:</b> C09D 129/04, 129/10, D04H 1/64, A61F 13/15, A47K 7/00	<b>A3</b>	<b>(11) International Publication Number:</b> WO 00/39378 <b>(43) International Publication Date:</b> 6 July 2000 (06.07.00)
<b>(21) International Application Number:</b> PCT/US99/31301 <b>(22) International Filing Date:</b> 30 December 1999 (30.12.99) <b>(30) Priority Data:</b> 60/114,325 31 December 1998 (31.12.98) US <b>(71) Applicant:</b> KIMBERLY-CLARK WORLDWIDE, INC. [US/US]; 401 North Lake Street, Neenah, WI 54956 (US). <b>(72) Inventors:</b> POMPLUN, William, S.; 928 Seven Lakes Drive, West End, NC 27376 (US). JACKSON, David, M.; 9825 Summer Oaks, Roswell, GA 30076 (US). MUMICK, Pavneet, S.; 1202 Taggart Drive, Belle Mead, NJ 08502 (US). CHANG, Yihua; N342 Candlelite Way, Appleton, WI 54915 (US). <b>(74) Agents:</b> WITHERS, James, D.; Jones & Askew, LLP, 2400 Monarch Tower, 3424 Peachtree Road, N.E., Atlanta, GA 30326 (US) et al.		<b>(81) Designated States:</b> AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, UZ, VN, YU, ZA, ZW, ARIPO patent (GH, GM, KE, LS, MW, SD, SL, SZ, TZ, UG, ZW), Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE), OAPI patent (BF, BJ, CF, CG, CI, CM, GA, GN, GW, ML, MR, NE, SN, TD, TG).  <b>Published</b> <i>With international search report.</i>  <b>(88) Date of publication of the international search report:</b> 21 September 2000 (21.09.00)
<b>(54) Title:</b> WATER-DISPERSIBLE NONWOVEN FABRICS CONTAINING TEMPERATURE-SENSITIVE OR ION-SENSITIVE POLYMERIC BINDER MATERIALS AND PROCESS FOR MAKING SUCH FABRICS		
<b>(57) Abstract</b> <p>The present invention is directed to a temperature-sensitive or ion-sensitive binder composition containing at least one temperature-sensitive or ion-sensitive polymeric material. The binder composition is either (1) insoluble in water containing greater than about 0.5 weight percent monovalent ions or water having a multivalent ion concentration greater than about 200 ppm multivalent ions, and soluble in water containing less than about 0.5 weight percent monovalent ions or water having a multivalent ion concentration less than about 200 ppm multivalent ions; or (2) insoluble in water having a temperature of greater than about 30 °C, and soluble in water having a temperature of less than about 25 °C. The present invention is further directed to a water-dispersible nonwoven fabric containing the temperature-sensitive or ion-sensitive binder material, which is useful in the manufacture of flushable personal care products. A process for making water-dispersible nonwoven fabrics is also provided.</p>		

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# INTERNATIONAL SEARCH REPORT

International Application No

PCT/US 99/31301

## A. CLASSIFICATION OF SUBJECT MATTER

IPC 7 C09D129/04 C09D129/10 D04H1/64 A61F13/15 A47K7/00

According to International Patent Classification (IPC) or to both national classification and IPC

## B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 7 C09D D04H A61F A47K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

## C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 5 509 913 A (YEO RICHARD S C). 23 April 1996 (1996-04-23) column 2, line 19 -column 4, line 51; claims; examples 5-7,9,11 ---	1-30
A	WO 98 36117 A (KIMBERLY CLARK CO) 20 August 1998 (1998-08-20) page 9, paragraph 1 -page 10, paragraph 2 ---	1-30
A	WO 98 41577 A (KIMBERLY CLARK CO) 24 September 1998 (1998-09-24) page 4, paragraph 2 ---	1, 11, 20, 21, 30
A	WO 97 02376 A (KIMBERLY CLARK CO) 23 January 1997 (1997-01-23) page 11, line 17 -page 12, line 19 --- -/-	1-30



Further documents are listed in the continuation of box C.



Patent family members are listed in annex.

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Date of the actual completion of the international search

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Name and mailing address of the ISA

European Patent Office, P.B. 5818 Patentlaan 2  
NL - 2280 HV Rijswijk  
Tel. (+31-70) 340-2040, Tx. 31 651 epo nl,  
Fax: (+31-70) 340-3016

Authorized officer

Barathe, R

# INTERNATIONAL SEARCH REPORT

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## C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	WO 98 29501 A (KIMBERLY CLARK CO) 9 July 1998 (1998-07-09) claims ---	1-30
A	EP 0 582 123 A (AIR PROD & CHEM) 9 February 1994 (1994-02-09) page 3, line 20 - line 51 ---	1-30
A	US 5 629 081 A (RICHARDS MARC F ET AL) 13 May 1997 (1997-05-13) the whole document -----	1-30

# INTERNATIONAL SEARCH REPORT

Information on patent family members

International Application No

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Patent document cited in search report	Publication date	Patent family member(s)	Publication date
US 5509913 A	23-04-1996	AU 687968 B	05-03-1998
		AU 1336395 A	03-07-1995
		BR 9408331 A	19-08-1997
		CA 2128483 A	17-06-1995
		CN 1142777 A	12-02-1997
		DE 4499925 T	19-12-1996
		GB 2284820 A, B	21-06-1995
		WO 9516474 A	22-06-1995
		ZA 9409979 A	22-08-1995
WO 9836117 A	20-08-1998	US 5948710 A	07-09-1999
		AU 719186 B	04-05-2000
		AU 6048898 A	08-09-1998
		BR 9807176 A	25-01-2000
		CN 1247583 T	15-03-2000
		EP 0961847 A	08-12-1999
		ZA 9800904 A	06-08-1998
WO 9841577 A	24-09-1998	US 5986004 A	16-11-1999
		AU 6464598 A	12-10-1998
WO 9702376 A	23-01-1997	AU 6289996 A	05-02-1997
		CA 2222461 A	23-01-1997
		EP 0835337 A	15-04-1998
		US 5952251 A	14-09-1999
		US 5948710 A	07-09-1999
WO 9829501 A	09-07-1998	US 5770528 A	23-06-1998
		AU 5523998 A	31-07-1998
		CN 1248987 A	29-03-2000
		EP 0963403 A	15-12-1999
EP 0582123 A	09-02-1994	US 5252332 A	12-10-1993
		AT 131228 T	15-12-1995
		CA 2100814 A	25-01-1994
		DE 69300949 D	18-01-1996
		DE 69300949 T	25-04-1996
		JP 2685162 B	03-12-1997
		JP 6198778 A	19-07-1994
US 5629081 A	13-05-1997	AU 695038 B	06-08-1998
		AU 5299396 A	16-10-1996
		CA 2214507 A	03-10-1996
		EP 0817876 A	14-01-1998
		JP 11502903 T	09-03-1999
		WO 9630576 A	03-10-1996



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10 WATER-DISPERSIBLE NONWOVEN FABRICS CONTAINING  
TEMPERATURE-SENSITIVE OR ION-SENSITIVE  
POLYMERIC BINDER MATERIALS AND PROCESS FOR  
MAKING SUCH FABRICS

15 FIELD OF THE INVENTION

The present invention relates to water-dispersible nonwoven fabrics. In a more specific aspect, the present invention relates to water-dispersible nonwoven fabrics, which contain temperature-sensitive or ion-sensitive polymeric binder materials. The present invention also relates to a process for the manufacture of such water-dispersible nonwoven fabrics.

BACKGROUND OF THE INVENTION

25 Personal care products (such as diapers, sanitary napkins, wipes, wound dressings, bandages, nursing pads and adult incontinence garments) are generally constructed from a number of different components and materials. Principal materials in personal care products are the coverstock (i.e., liner) and the intake (i.e., surge) materials, which are commonly comprised of nonwoven fabrics. For purposes of this application, the terms "nonwoven fabrics", "nonwoven fibrous webs", "fabrics", "fabric webs" and "fibrous substrates" may be used interchangeably and include methods of making such fabrics and webs, such as meltblowing, melt spinning, air laying and wet laying methods.

35 The surge material must be constructed to receive and absorb various liquids, and the liner material must be constructed to prevent or at least minimize the exudation of such liquids.

40 Although personal care products are relatively inexpensive, sanitary and easy to use, the proper disposal of a soiled product is not without problems. With greater interest being placed

5 in protecting the environment today, there is a need to develop  
materials that are more compatible with the existing and developing  
water disposal technologies while still delivering the performance  
which consumers have come to expect and demand. An ideal  
10 disposal alternative would be to use municipal sewage treatment  
and private residential septic systems. Products suited for disposal  
in sewage systems can be flushed down a convenient toilet and are  
termed "flushable." To function effectively as liner and surge  
materials, nonwoven fabrics must maintain their structural integrity  
and exhibit satisfactory tensile strength when wet or damp.  
15 However, if nonwoven fabrics were to lose substantially all of their  
tensile strength when exposed to water and become dispersible in  
such water, the disposal problem could be substantially eliminated.  
These materials could then be conveniently flushed down a  
conventional toilet system.

20 Desirably, the nonwoven fabrics possess a number of  
characteristics, such as softness and flexibility. The fabric is usually  
formed by wet or dry laying a random plurality of fibers, which are  
then joined together to form a coherent web. Unfortunately, in an  
attempt to provide nonwoven fabrics having certain in-use  
25 characteristics, prior methods have rendered the fabric non-  
dispersible in water. For example, nonwoven fabrics have been  
bonded with fluid-insoluble resins which impart in-use strength.  
However, such resins impede flushing the fabric by rendering the  
fabric substantially water insoluble.

30 With regard to pre-moistened wipes, special problems  
arise. The wipes, which are used for skin cleansing and are known  
commercially as towelettes, wet wipes or fem-wipes, are formed  
from paper or nonwoven fibrous webs treated with a polymeric  
binder. The binder imparts to the web a degree of wet strength so  
35 that the web will maintain tensile strength while being stored in an  
appropriate liquid medium. However, after the wipe has been used,  
the binder should be readily weakened when exposed to an  
aqueous environment, such as a toilet, without clogging the toilet  
and plumbing.

5                Various binders have been used in the manufacture of  
a wipe. For example, wipes have included as a binder an acid-  
insoluble, alkali-soluble polymeric polycarboxylic acid and  
functional derivatives thereof wherein the acid is placed in water  
and enough alkali is added to substantially neutralize all acidic  
10       groups prior to applying the binder to the web. The binder-  
saturated web is dried and then immersed in a low pH medium  
where the web retains its structural integrity yet will still break up  
when the wipe is immersed in a sufficiently high pH liquid medium.

15              Another binder used for a pre-moistened wipe has  
been polyvinyl alcohol combined with a gelling or insolubilizing  
agent such as borax. The borax crosslinks at least the surface of  
the polymer binder before drying the web to give a water resistant  
web. Such cross-links are reversible, that is, when the  
concentration of borax is reduced below a certain level, the degree  
20       of cross-linking is so low that the binder becomes soluble in water.  
However, boron-containing solutions are unacceptable for personal  
care products due to safety concerns.

25              Yet another water-dispersible nonwoven fabric has  
used a water-soluble binder comprising a partially neutralized  
unsaturated carboxylic acid/unsaturated carboxylic acid ester  
copolymer. A problem with this binder is that to prevent the  
nonwoven fibrous fabric from disintegrating prior to disposal, the  
wipe must be maintained in a solution having a pH which may  
cause irritation to the skin when the wipe is used.

30              Binders containing carboxylate groups have worked  
well for making a water-dispersible fibrous web that is, to a limited  
degree, water soluble, water-dispersible or water-disintegratable in  
an aqueous environment, provided the water is predominantly void  
of divalent ions. However, in those areas where the water is  
35       "moderately hard", because the water contains divalent ions such  
as calcium ions or magnesium ions, the wipes do not readily  
disperse. The water soluble polymeric binder is substantially  
rendered insoluble by the presence of divalent ions. It is believed  
that the divalent ions crosslink the binder and prevent the binder  
40       from dispersing in the water. The adverse effect that divalent ions

5 present in the aqueous environment has on the water solubility of the polymeric binder has not been recognized.

Accordingly, there is a need for a water-dispersible binder composition that can be used in a personal care product, such as a wipe, that is safe to use and will be substantially  
10 unaffected by the present of divalent ions normally found in moderately hard water.

### SUMMARY OF THE INVENTION

Briefly described, the present invention provides a  
15 water-dispersible nonwoven fabric, which can be used in flushable personal care products. More specifically, the present invention provides a water-dispersible nonwoven fabric, which contains a temperature-sensitive or ion-sensitive polymeric binder material.

The present invention also provides a process for the  
20 manufacture of water-dispersible nonwoven fabrics in which the fibers used to form the nonwoven fabrics are bound together with a temperature-sensitive or ion-sensitive polymeric binder material.

The present invention further provides flushable  
25 personal care products, which are made from the water-dispersible nonwoven fabrics provided by the present invention.

These and other objects, features and advantages of  
this invention will become apparent from the following detailed description.

30

### DETAILED DESCRIPTION OF THE INVENTION

The present invention is directed to binder  
compositions, which may be used to produce nonwoven fabrics for  
35 use in flushable personal care products. The binder compositions possess unique properties, which enable the production of "water-dispersible" products. The binder compositions of the present invention are "ion-sensitive", "temperature-sensitive", or both ion and temperature-sensitive materials. In order to be an effective  
40 "ion-sensitive" or "temperature-sensitive" material suitable for use

5 in flushable personal care products, the binder composition should desirably be (1) functional, i.e., maintain wet strength under controlled conditions and dissolve or disperse rapidly in soft or hard water such as found in a toilets and sinks around the world; (2) safe (not toxic); and (3) economical.

10 As used herein, the term "ion-sensitive" refers to the solubility and dispersibility of a binder composition, which varies depending upon the amount of monovalent and/or multivalent ions present in an aqueous solution. As used herein, the term "monovalent" refers to ions having a charge of 1, such as  $\text{Na}^+$  and  $\text{Cl}^-$  ions. As used herein, the term "multivalent" refers to ions having a charge of greater than 1, such as  $\text{Ca}^{2+}$  and  $\text{CO}_3^{2-}$  ions. In the present invention, the "ion-sensitive" binder compositions remain insoluble in aqueous compositions having a monovalent salt concentration greater than about 0.5 weight percent or a multivalent ion concentration containing greater than about 200 ppm. However, the "ion-sensitive" binder compositions become soluble in aqueous compositions having a monovalent salt concentration less than about 0.5 weight percent or a multivalent ion concentration containing less than about 200 ppm.

25 In order to be effective as a binder material in flushable products throughout the United States, the ion-sensitive binder compositions of the present invention remain stable and maintain their integrity while dry or in high concentrations of monovalent and/or multivalent ions, but become soluble in water containing up to about 200 ppm  $\text{Ca}^{2+}$  ions. Desirably, the ion-sensitive binder compositions of the present invention are insoluble in a salt solution containing at least about 0.5 weight percent of one or more inorganic and/or organic salts containing monovalent and/or multivalent ions. More desirably, the ion-sensitive binder compositions of the present invention are insoluble in a salt solution containing from about 0.5 wt% to about 5.0 wt% of one or more inorganic and/or organic salts containing monovalent and/or multivalent ions. Even more desirably, the ion-sensitive binder compositions of the present invention are insoluble in a salt solution containing from about 0.5 wt% to about 3.0 wt% of one or more

5 inorganic and/or organic salts containing monovalent and/or multivalent ions. Suitable monovalent and/or multivalent ions include, but are not limited to,  $\text{Na}^+$  ions,  $\text{K}^+$  ions,  $\text{Li}^+$  ions,  $\text{NH}_4^+$  ions,  $\text{Cl}^-$  ions,  $\text{Ca}^{2+}$  ions,  $\text{Mg}^{2+}$  ions,  $\text{Zn}^{2+}$  ions,  $\text{CO}_3^{2-}$  ions,  $\text{SO}_4^{2-}$  ions, and a combination thereof.

10 Based on a recent study conducted by the American Chemical Society, water hardness across the United States varies greatly, with  $\text{CaCO}_3$  concentration ranging from near zero for soft water to about 500 ppm  $\text{CaCO}_3$  (about 200 ppm  $\text{Ca}^{2+}$  ion) for very hard water. To ensure polymer dispersibility across the United  
15 States, the ion-sensitive binder compositions of the present invention are desirably soluble in water containing up to about 50 ppm  $\text{Ca}^{2+}$  and/or  $\text{Mg}^{2+}$  ions. More desirably, the ion-sensitive binder compositions of the present invention are soluble in water containing up to about 100 ppm  $\text{Ca}^{2+}$  and/or  $\text{Mg}^{2+}$  ions. Even  
20 more desirably, the ion-sensitive binder compositions of the present invention are soluble in water containing up to about 150 ppm  $\text{Ca}^{2+}$  and/or  $\text{Mg}^{2+}$  ions. Even more desirably, the ion-sensitive binder compositions of the present invention are soluble in water containing up to about 200 ppm  $\text{Ca}^{2+}$  and/or  $\text{Mg}^{2+}$  ions.

25 Further, as used herein, the term "temperature-sensitive" refers to the solubility and dispersibility of a binder composition, which varies depending upon the temperature of an aqueous solution. In the present invention, the "temperature-sensitive" binder compositions remain insoluble in aqueous  
30 compositions having a temperature greater than about 37 °C. However, the "temperature-sensitive" binder compositions become soluble in aqueous compositions having a temperature less than about 20 °C. Desirably, the "temperature-sensitive" binder compositions remain insoluble in aqueous compositions having a  
35 temperature greater than about 32 °C, and become soluble in aqueous compositions having a temperature less than about 22 °C. More desirably, the "temperature-sensitive" binder compositions remain insoluble in aqueous compositions having a temperature greater than about 30 °C, and become soluble in aqueous  
40 compositions having a temperature less than about 25 °C.

5                   The binder compositions of the present invention  
comprise at least one polymeric material, which is ion-sensitive,  
temperature-sensitive, or both. Suitable ion-sensitive and/or  
temperature-sensitive polymeric materials include, but are not  
10                   limited to, poly(vinyl alcohol), poly(vinyl methyl ether),  
hydroxypropyl cellulose, alkyl hydroxypropyl cellulose, such as  
methyl hydroxypropyl cellulose, and combinations thereof. The  
binder compositions of the present invention comprise up to 100  
weight percent of at least one ion-sensitive and/or temperature-  
sensitive polymeric material. Desirably, the binder compositions of  
15                   the present invention comprise from about 25 to about 99 weight  
percent of at least one ion-sensitive and/or temperature-sensitive  
polymeric material and from about 75 to about 1 weight percent of  
at least one "other polymer." As used herein, the term "other  
polymer" refers to polymer, which do not have either the ion-  
20                   sensitive or the temperature-sensitive property as described above.  
More desirably, the binder compositions of the present invention  
comprise from about 40 to about 95 weight percent of at least one  
ion-sensitive and/or temperature-sensitive polymeric material and  
from about 60 to about 5 weight percent of at least one other  
25                   polymer. Even more desirably, the binder compositions of the  
present invention comprise from about 40 to about 75 weight  
percent of at least one ion-sensitive and/or temperature-sensitive  
polymeric material and from about 60 to about 25 weight percent  
of at least one other polymer.

30                   Suitable other polymers include, but are not limited to,  
water-soluble binders such as polyvinyl alcohol, aqueous dispersions  
of, for example, polyvinyl chloride, polyacrylates, and copolymers  
of acrylates and methacrylates; polystyrene, styrene-acrylonitrile  
copolymer, acrylonitrile-butadiene-styrene terpolymer, ethylene-  
35                   acrylic acid copolymer, ethylene-methacrylic acid copolymer,  
polyolefins grafted with polar functional groups such as hydroxyl  
groups, polyacrylates, polymethacrylates, polyvinyl butyral,  
polyurethanes, polyesters, polyamides, polyvinyl acetate,  
polyethylene vinyl acetate, ethylene-vinyl alcohol copolymer, and  
40                   combinations thereof. It should be noted that all grades of

5 polyvinyl alcohol may be used as the other polymer, including  
water-insoluble grades. Desirably, the other polymer comprises  
one or more water-soluble binders such as polyvinyl alcohol,  
polyvinyl acetate, polyvinyl chloride, polyacrylates, and copolymers  
10 of acrylates and methacrylates. The choice and number of suitable  
other polymers to be blended with the ion-sensitive and/or  
temperature-sensitive polymeric material is not limited, as long as  
the resulting binder composition blend possesses desired properties  
(i.e., ion-sensitive and/or temperature-sensitive solubility,  
15 dispersibility in cold water, etc.) suitable for use in water-dispersible  
products.

In accordance with one embodiment of the present  
invention, the binder composition comprises from about 25 to  
about 99 weight percent of at least one polymeric material selected  
from poly(vinyl alcohol), poly(vinyl methyl ether), and methyl  
20 hydroxypropyl cellulose; and from about 75 to about 1 weight  
percent of polyvinyl acetate.

In some embodiments, it may be desirable to employ  
one or more additives to the binder compositions of the present  
invention. Suitable additives include, but are not limited to,  
25 antioxidants, antistatic agents, blowing agents, compatibilizers,  
flame retardants, heat stabilizers, impact modifiers, lubricants,  
plasticizers, ultraviolet stabilizers, processing aids, dispersants, slip  
agents, perfumes, colorants, antifoams, bactericides, bacteriostats,  
surface active agents, thickening agents, fillers, etc., depending on  
30 the specific properties desired in the binder composition and  
products made therefrom. Typically, such additives are  
incorporated into the binder compositions of the present invention  
in an amount up to about 10 weight percent of total weight percent  
of the binder composition.

35 In one embodiment of the present invention, a  
plasticizer is incorporated into the above-described binder  
compositions. Suitable plasticizers include, but not limited to,  
glycerol; sorbitol; emulsified mineral oil; dipropyleneglycol di-  
benzoate; polyglycols such as polyethylene glycol, polypropylene  
40 glycol and copolymers thereof; decanoyl-N-methylglucamide;



5        tributyl citrate; and tributoxyethyl phosphate may be added to the solution containing the binder composition.

10        One advantage of the polymeric binder compositions of the present invention is their relative insensitivity toward divalent cations found in hard water because of the lack of cross-linking sites along the ion-sensitive and/or temperature-sensitive polymeric materials of the compositions. Unlike other binder compositions, the binder compositions of the present invention find versatile applicability to a variety of end uses due to the unique properties of the binder materials.

15        The binder compositions of the present invention are particularly useful in making "water-dispersible" nonwoven fabrics. As used herein, the term "water-dispersible" refers to the ability of a fabric to disintegrate and/or disperse into pieces of fabric when agitated in water having a low ion content (i.e., water having a monovalent salt concentration less than about 0.5 weight percent or 20        a multivalent ion concentration containing less than about 200 ppm) or in cold water (i.e., below about 25 °C). Desirably, the water-dispersible fabric separates into multiple pieces each having an average size of less than about 50%, desirably less than about 25        40%, and more desirably less than about 30%, relative to the pre-dispersed size within about 20 minutes, and desirably within about 10 minutes, and more desirably within about 2 minutes in an aqueous environment. As used herein, the term "nonwoven fabric" refers to a fabric that has a structure of individual fibers or 30        filaments randomly arranged in a mat-like fashion. Nonwoven fabrics can be made from a variety of processes including, but not limited to, air-laid processes, wet-laid processes, hydroentangling processes, staple fiber carding and bonding, and solution spinning.

35        Nonwoven fabrics prepared in accordance with the present invention have good dry tensile strength, but readily disperse in water having a low ion content or a low temperature. The nonwoven fabrics are abrasion resistant and retain significant tensile strength in aqueous solutions, which either contain a high concentration of salt or have a temperature above the "trigger 40        temperature" of the polymeric material. As used herein the phrase

5 "trigger temperature" refers to the lower critical solution  
temperature (LCST) or the cloud point temperature of the  
temperature-sensitive polymeric material. In one embodiment of  
the present invention, the polymeric material may be further  
10 insolubilized by adding an appropriate organic solvent to the water  
to form a "non-cosolvency effect." As used herein, the phrase  
"non-cosolvency effect" refers to the formation of a "poor co-  
solvent" (i.e., a mixture of two or more solvents in which the  
solubility of a given polymeric material is very low) from two or  
more "good solvents" (i.e., solvents in which the given polymeric  
15 material has good solubility, when the solvents are separate from  
one another). Suitable organic solvents for forming a non-  
cosolvency effect include, but are not limited to, methanol and  
ethanol.

Desirably, the nonwoven fabrics of the present  
20 invention are readily dispersible in soft to moderately hard water.  
As used herein, the term "soft water" refers to water having a  
divalent ion content of less than about 10 ppm. As used herein, the  
term "moderately hard water" refers to water having a divalent  
ion content of from about 10 to about 50 ppm. As used herein, the  
25 term "hard water" refers to water having a divalent ion content of  
more than about 50 ppm. Because of this latter property, the  
nonwoven fabrics of the present invention are well suited for  
disposable personal care products such as sanitary napkins, diapers,  
and dry and pre-moistened wipes, which can be thrown in a flush  
30 toilet after use.

The binder materials are particularly useful for binding  
fibers of air-laid nonwoven fabrics. These air-laid materials are  
particularly useful for a variety of products including, but not  
limited to, body-side liners, fluid distribution materials, fluid in-take  
35 materials (such as a surge material) and absorbent wrap sheet and  
cover stock for various water-dispersible personal care products.  
Air-laid materials are particularly useful for use as a pre-moistened  
wipe. The basis weights for these air-laid non-woven fabrics will  
desirably range from about 20 to about 200 grams per square  
40 meter (gsm). Surge or in-take materials, which need better

5        resiliency and higher loft, desirably comprise staple fibers having  
about 6 denier or greater to make these products. A desirable final  
density for the surge or in-take materials is between about 0.025  
grams per cubic centimeter (g/cc) to about 0.050 g/cc. Fluid  
10       distribution materials will have a higher density, desirably in the  
range of about 0.10 to about 0.20 g/cc using fibers of lower denier.

      The nonwoven fabrics of the present invention  
may be formed of natural fibers, synthetic fibers and combinations  
thereof. The choice of fibers depends upon, for example, fiber cost  
and the intended end use of the finished fabric. Examples of  
15       suitable fibrous substrates, which can be used alone or in any  
combination, include, but are not limited to, cotton, linen, jute,  
hemp, wool, wood pulp, regenerated cellulosic fibers such as  
viscose rayon, modified cellulosic fibers such as cellulose acetate, or  
synthetic fibers derived from polyvinyl alcohol, polyesters,  
20       polyamides, polyacrylics, etc. Blends of one or more of the above  
fibers may also be used. In one embodiment of the present  
invention, a combination of wood pulp and synthetic man-made  
fibers is used to form a nonwoven fabric. Desirably, the synthetic  
man-made fibers have a fiber denier of less than about 1.5.

25       In a further embodiment of the present invention, the  
nonwoven fabric is formed from relatively short fibers, such as  
wood pulp fibers. The minimum length of the fibers depends on  
the method selected for forming the nonwoven fabric. For  
example, where the fibrous substrate is formed by carding, the  
30       length of the fiber should usually be at least about 42 mm in order  
to insure uniformity. Where the fibrous substrate is formed by air-  
laid or wet-laid processes, the fiber length may desirably be about  
0.1 millimeters to 15 millimeters. Although fibers having a length  
of greater than 50 mm are within the scope of the present  
35       invention, it has been determined that when a substantial quantity  
of fibers having a length greater than about 15 mm is placed in a  
flushable fabric, though the fibers will disperse and separate in  
water, their length tends to form "ropes" of fibers which are  
undesirable when flushing in home toilets. Therefore, for these  
40       products, it is desired that the fiber length be about 15 mm or less

5 so that the fibers will not have a tendency to "rope" when they are  
flushed through a toilet. Although fibers of various length are  
applicable in the present invention, desirably fibers are of a length  
less than about 15 mm so that the fibers disperse easily from one  
another when in contact with water, most desirably ranging from  
10 about 6 mm to about 15 mm in length. Desirably, the nonwoven  
fabrics of the present invention have a relatively low wet cohesive  
strength in tap water and sewer water, so that the fabric will break  
up readily from the agitation provided by flushing and moving  
through the sewer pipes.

15 The nonwoven fabrics of the present invention may be  
formed from a single layer or multiple layers. In the case of  
multiple layers, the layers are generally positioned in a juxtaposed  
or surface-to-surface relationship and all or a portion of the layers  
may be bound to adjacent layers. The nonwoven fabric may also  
20 be formed from a plurality of separate nonwoven fabrics wherein  
the separate nonwoven fabrics may be formed from a single or  
multiple layers. The binder may be distributed on the nonwoven  
fabric as a single application or where there are multiple layers,  
each individual layer may be separately subjected to a binder  
25 application and then combined with other layers in a juxtaposed  
relationship to form the finished nonwoven fabric.

Another embodiment of the present invention is a  
process of making a water-dispersible nonwoven fabric. The  
method includes the steps of contacting the fibrous substrate with  
30 an effective amount of the binder composition of the present  
invention to bind a substantial amount of the fibers and then drying  
the fabric to form a water-dispersible fibrous fabric. For ease of  
applying the binder to the nonwoven fabric, the binder may be  
emulsified, dispersed and/or dissolved in water or another solvent  
35 such as methanol, ethanol or the like, with water being the  
preferred solvent. The binder desirably has from about 1 to about  
50 weight percent solids, and more desirably from about 2.5 to  
about 20 weight percent solids.

The binder material may be applied to the nonwoven  
40 fabric by any known process of application, such as by spraying,

5 dipping, printing, coating or any other technique. When the binder  
is applied to the nonwoven fabric to retain the integrity of the  
fabric, the binder is desirably, uniformly dispersed in substantially  
all of the fabric to cover substantially all of the fiber junctions.  
Based on the total weight of the nonwoven fabric, desirably the  
10 binder may be distributed or "added on" to the nonwoven fabric  
in an amount of from about 1 to about 50 weight percent, more  
desirably from about 5 to about 30 weight percent, even more  
desirably from about 8 to about 25 weight percent, and even more  
desirably from about 12 to about 18 weight percent.

15

Once the binder composition is applied to the fabric,  
the fabric may be dried by conventional means. Once dry, the  
coherent fibrous fabric exhibits improved tensile strength when  
20 compared to the tensile strength of a similar but untreated wet-laid  
or dry-laid fabric. For example, the tensile strength of the fabric  
may be increased by at least 25 percent compared to the tensile  
strength of the untreated fabric. More particularly, the tensile  
strength of the fabric may be increased by at least about 100  
25 percent and even more particularly the tensile strength of the fabric  
may be increased by at least about 500 percent as compared to an  
untreated fabric. However, and quite advantageously, the fabric  
will disintegrate or is disintegratable when placed in soft to  
moderately hard water, or cold water, and agitated.

30 The water-dispersible nonwoven fabrics of the present  
invention are particularly suitable for use in water-dispersible  
products. Suitable products include, but are not limited to, wipes,  
sanitary napkins, diapers, surgical dressings, tissues, and the like. In  
many products, particularly personal care products, nonwoven  
35 fabrics are preferred due to their absorptivity of fluids such as  
blood, menses and urine. The nonwoven fabrics of the present  
invention may be incorporated into a variety of body fluid-  
absorbing products including, but not limited to, sanitary napkins,  
diapers, surgical dressings, tissues, and the like. The binder  
40 compositions of the present invention enable the resulting

5 nonwoven fabrics to remain intact when contacted by body fluids, since the concentration of divalent ions in the body fluids is above the level of dissolution. The nonwoven fabric retains its structure, softness and exhibits a toughness satisfactory for practical use. However, the binder dissolves and the fabric disperses when  
10 brought into contact with water having either a low salt concentration (i.e., below about 0.5 weight percent) or a temperature about room temperature. In one embodiment of the present invention, the nonwoven fabrics are in the form of wipes. The finished wipes may be individually  
15 packaged, desirably in a folded condition, in a moisture proof envelope or package in containers holding any desired number of pre-folded sheets and stacked in a water-tight package with a wetting agent applied to the wipe. The wetting agent may comprise, by weight, from about 10 weight percent to about 400  
20 weight percent of the dry weight of the wipe itself. The wipe must maintain its desired characteristics over the time periods involved in warehousing, transportation, retail display and storage by the consumer. Accordingly, shelf life may range from as little as two months to up to two years.

25 Various forms of impermeable envelopes for containing wet-packaged materials, such as wipes and towelettes and the like, are well known in the art. Any of these may be employed in packaging the pre-moistened wipes of the present invention.

30 Those skilled in the art will readily understand that the binder compositions and fibrous substrates of the present invention may be advantageously employed in the preparation of a wide variety of products, including but not limited to, absorbent personal care products designed to be contacted with body fluids. Such  
35 products may only comprise a single layer of the fibrous substrate or may comprise a combination of elements as described above. Although the binder compositions and fibrous substrates of the present invention are particularly suited for personal care products, the binder compositions and fibrous substrates may be  
40 advantageously employed in a wide variety of consumer products.

5 Further, although the binder compositions are particularly useful in the formation of nonwoven fabrics, the binder compositions may also be used in the formation of woven or knit fabrics, wherein the binder composition is used as a fiber sizing material or a fabric coating material.

10 The present invention is further illustrated by the following examples, which are not to be construed in any way as imposing limitations upon the scope thereof. On the contrary, it is to be clearly understood that resort may be had to various other embodiments, modifications, and equivalents thereof which, after  
15 reading the description herein, may suggest themselves to those skilled in the art without departing from the spirit of the present invention and/or the scope of the appended claims.

20

## EXAMPLES

### *Preparation of Binder Materials:*

#### Binder No. 1:

25 This binder was based on polyvinyl alcohol and comprised the following components given in parts by weight:

157.2 parts of 15 weight percent polyvinyl alcohol marketed under the trade designation KP-6 by Nippon Gohsei Company (15 wt% PVOH and 85 wt% water);

30 42.8 parts of 55 weight percent polyvinyl acetate emulsion marketed under the trade designation VINAC® XX-210 by Air Products, Inc. (55 wt% PVA and 45 wt% water);

192 parts water; and

3.93 parts anhydrous sodium sulfate.

Total solids content: 12.0 weight percent.

35

To dissolve polyvinyl alcohol in water, the desired amount of poly (vinyl alcohol) powder was added slowly to well-agitated hot water at 80-90°C. The hot slurry was allowed to cool to room temperature with continued agitation. The agitation was  
40 continued until all particles were dissolved and the solution was free

5 of gel. High shear agitation was necessary to ensure complete dispersion when polyvinyl alcohol was added to water, but was not necessary in the subsequent dissolution step.

Alternatively, to dissolve polyvinyl alcohol in water, the desired amount of polyvinyl alcohol was added to water at  
10 room temperature with agitation. The agitation was continued until the polyvinyl alcohol was dissolved. In this method, the time factor was more important than high shear to ensure complete solution of the gel particles.

To prepare the binder solution, the desired amount of  
15 sodium sulfate was dissolved in water, and this solution was then added to the polyvinyl alcohol solution under agitation, followed by the addition of the polyvinyl acetate emulsion. The viscosity of the final binder composition was about 68 centipoises, but this composition was not stable as phase separation occurred over time  
20 upon standing. However, a uniform composition was regenerated with agitation.

Binder No. 2:

This binder was based on polyvinyl methyl ether and  
25 comprised the following components given in parts by weight:

7.50 parts polyvinyl methyl ether solution  
obtained as a 50 weight percent solids solution under the trade  
designation LUTANOL® M-40 from BASF Corporation;

72.05 parts deionized water; and  
30 20.45 parts polyvinyl acetate emulsion as in  
Binder No. 1.

Total solids content: 15.0 weight percent.

The polyvinyl methyl ether solution was added to the  
35 deionized water at room temperature. After thorough mixing, the polyvinyl acetate emulsion was added with vigorous stirring to obtain a homogeneous mixture. The composition phase separated over time upon standing, but a homogeneous mixture was regenerated upon vigorous agitation. The viscosity of the final  
40 binder composition was about 41 centipoises.



5

Binder No. 3:

This binder was based on methyl hydroxypropyl cellulose and comprised the following components given in parts by weight:

10

83.0 parts methyl hydroxypropyl cellulose; and  
17.0 parts polyvinyl acetate emulsion as in

Binder No. 1.

Total solids content: 12.0 weight percent.

15

The desired amount of methyl hydroxypropyl cellulose powder (marketed under the trademark BENECEL<sup>®</sup> MP-943 by Aqualon Chemical Company) was added to deionized water at 70-75°C. Under vigorous agitation, the water temperature was allowed to drop to room temperature. The agitation was continued until all of the powder was in solution.

20

To this solution, the polyvinyl acetate was added with vigorous stirring. The stirring was continued until a homogeneous mixture was obtained. The composition phase separated over time upon standing, but a homogeneous mixture was regenerated upon vigorous agitation. The viscosity of the final binder composition was about 50 to about 200 centipoises.

25

Binder No. 4:

This binder was based on poly(vinyl methyl ether) and comprised the following components given in parts by weight:

30

15.0 parts polyvinyl methyl ether solution as in

Binder No. 2;

71.4 parts deionized water; and

35

13.6 parts vinyl acetate-ethylene emulsion marketed under the trademark AIRFLEX<sup>®</sup> 300 by Air Products, Inc.

Total solids content: 15.0 weight percent.

40

The polyvinyl methyl ether solution was added to the deionized water at room temperature. After thorough mixing, the

5 vinyl acetate-ethylene emulsion was added with vigorous stirring to obtain a homogeneous mixture. The composition phase separated over time upon standing, but a homogeneous mixture was regenerated upon vigorous agitation. The viscosity of the final mixture was between about 40 to about 60 centipoises.

10

### EXAMPLE 1

A web containing 75 gsm (grams per square meter) of a mixture of southern softwood Kraft fluff (SSWK) pulp from Rayonier (Jesup, GA) and 6 mm/6 d/f (denier per filament) polyester from KoSa (Charlotte, N.C.) (50:50 weight percent blend) was sprayed with 25 gsm Binder No. 1 to provide a web with an overall basis weight of 100 gsm. This material was found to have some weak areas because of the high viscosity of the binder solution, which prevented good spray coverage of the web. However, this material was found to have instant wetting capability and dispersed in cold tap water.

Another web containing 90 gsm of the same fiber mixture was sprayed with a diluted solution of Binder No. 1 at a level of 10 gsm. Poor spray coverage of the binder was evident from observing the shallow spray cone angle (about 25°). Good bulk was achieved (about 3 mm thickness) and low density (0.03 g/cm<sup>3</sup>), which are important for designing a good fluid intake material.

30

### EXAMPLE 2

A web containing 95 gsm CEMFIBER® (Varde, Denmark) polypropylene (6mm/2 d/f) and Rayonier SSWK pulp (50:50 weight percent blend) was sprayed with 5 gsm Binder No. 1 to provide a web with an overall basis weight of 100gsm. Again, poor binder coverage was observed due to shallow cone spray angle. The material was found to be cold water dispersible in tap water.

40

5

## EXAMPLE 3

A web containing 23 gsm CEMFIBER<sup>®</sup> polypropylene (6mm/2 d/f) formed on a tissue carrier web was sprayed with 2 gsm Binder No. 1 to provide a web with an overall basis weight of 25 gsm. Poor web formation was observed using straight polypropylene fiber, and the binder was found to be mostly transferred to the tissue carrier web, creating a weakly bonded material.

A second web was formed using 80 wt% CEMFIBER<sup>®</sup> polypropylene (6mm/2 d/f) fibers and 20 wt% Rayonier SSWK pulp. The web had improved fiber formation, but the high viscosity of Binder No. 1 left one side of the web bonded and the other side only weakly bonded because of poor penetration.

20

## EXAMPLE 4

A web containing 28 gsm rayon fibers (available under the tradename TENCEL<sup>®</sup> from Acordis Cellulosic Fibers, Inc., Mobile, AL) (6mm / 3d/f) and Rayonier SSWK pulp (75:25 weight percent blend) was sprayed with 8 gsm Binder No. 2 on one side to provide a web with an overall basis weight of 36 gsm. Although the web was "harsher" feeling than webs containing polypropylene, instant wettability was significantly improved using Binder No. 2. The web remained intact when hot water (> than 40°C) was poured onto the web, but when placed in cold tap water, the web dispersed rapidly.

A similar fabric was prepared, but the basis weight of the fiber blend was reduced to 24 gsm and Binder No. 2 was applied at a level of 3 gsm per side. The rayon/pulp fiber makeup with binder applied to both sides was "harsher" to the touch than previous polypropylene based webs.

35

## EXAMPLE 5

A web containing 29 gsm CEMFIBER<sup>®</sup> polypropylene (6mm / 2d/f) and Rayonier SSWK pulp (75:25 weight percent blend) was sprayed with Binder No. 2, 4 gsm per

40

5 side to provide a web with an overall basis weight of 37 gsm. A  
second fabric was produced keeping the fiber blend basis weight at  
29 gsm, but spraying Binder No. 2 at a 7 gsm level on one side  
only to form a web with an overall basis weight of 36 gsm. Even  
10 with the polypropylene fibers added to the fiber blend, the webs  
seemed somewhat "harsh" to the touch. The added "harshness"  
was a result of the poly(vinylacetate) additive in Binder No. 2.  
Both webs stayed intact when warm water passed through them,  
but broke up rapidly in cold tap water.

15 EXAMPLE 6

A web containing 31 gsm CEMFIBER®  
polypropylene (6mm / 2d/f) and Rayonier SSWK pulp (75:25  
weight percent blend) was sprayed with 7 gsm of Binder No. 3 on  
one side to provide a web with an overall basis weight of 38 gsm.  
20 Like Binder No. 1, the high viscosity of Binder No. 3 prevented a  
good spray pattern (about 45°) leading to poor coverage of the  
binder on the web. This material had good instant wetting  
capability, but not as good as Binder No. 2 based webs.

25 EXAMPLE 7

A web containing 31 gsm CEMFIBER®  
polypropylene (6mm / 2d/f) and Rayonier SSWK pulp (75:25  
weight percent blend) was sprayed with 7 gsm Binder No. 4 on  
one side to achieve a web with an overall basis weight of 38 gsm.  
30 A second fabric was prepared reducing the fiber blend basis weight  
to 27 gsm and spraying both sides of the web with Binder No. 4 at  
a level of 3 gsm per side, which provided a web with an overall  
basis weight of 33 gsm. This binder exhibited an excellent spray  
pattern (cone angle of 90°) and provided good coverage on the  
web. The webs were also much softer to the touch, which was  
35 attributed to the polyvinylacetate-co-ethylene component in Binder  
No. 4, which is less "harsh" than the polyvinylacetate component  
in Binder No. 2. Like the webs made with Binder No. 2, webs  
made with the Binder No. 4 allowed warm water to pass through  
40 without destroying the integrity of the web, but when placed in

5 cold tap water the web quickly disintegrated. These webs were soft to the touch, but did not have adequate integrity. The polyvinylmethylether component in Binder No. 4 was responsible for maintaining integrity in warm water, but allowing the web to break up in cold tap water.

10

#### EXAMPLE 8

A web containing 90 gsm polyester (6mm / 6d/f) and Rayonier SSWK pulp (50:50 weight percent blend) was sprayed with 5 gsm Binder No. 2 on both sides to provide a web with an overall basis weight of 100 gsm. Binder No. 2 along with the stiff polyester fibers produced a web with good resiliency, high loft (3-4 mm thick), and low density ( $0.03\text{g/cm}^3$ ), which met the desired initial requirements for a fluid intake (surge) material. Upon contact with warm water, the web maintained its resiliency and integrity, but slowly broke up in cold tap water. The polyvinylacetate component in Binder No. 2 was responsible for good web integrity, while the polyvinyl methyl ether provided the trigger mechanism to allow web breakup in cold water.

25

#### EXAMPLE 9

A web containing 90 gsm polyester (6mm / 6d/f) and Weyerhaeuser NB420 fluff pulp (available from Weyerhaeuser, Federal Way, WA) (50:50 weight percent blend) was sprayed with 5 gsm Binder No. 2 on both sides to provide a web with an overall basis weight of 100 gsm. Like Example 8, the Weyerhaeuser pulp, with the same combination of polyester fibers and Binder No. 2, provided a web that met the desired initial requirements for a intake (surge) material. The purpose of making webs with two fiber types was to investigate later the effect of fiber type on flushability/dispersibility of composite materials and finally personal care products.

40

The present invention has been described in detail with particular reference to certain embodiments, but variations and

- 5        modifications can be made without departing from the spirit and scope of the invention as defined in the following claims.

5

## CLAIMS

What is claimed is:

10           1.    A temperature-sensitive or ion-sensitive binder composition comprising at least one temperature-sensitive or ion-sensitive polymeric material, wherein (a) the binder composition is insoluble in water containing greater than about 0.5 weight percent monovalent ions or water having a multivalent ion concentration greater than about 200 ppm multivalent ions, and is soluble in  
15           water containing less than about 0.5 weight percent monovalent ions or water having a multivalent ion concentration less than about 200 ppm multivalent ions; or (b) the binder composition is insoluble in water having a temperature of greater than about 30 °C, and is soluble in water having a temperature of less than about 25 °C.

20

          2.    The binder composition of Claim 1, wherein the binder composition is insoluble in water having a multivalent ion concentration greater than about 200 ppm multivalent ions, and is soluble in water having a multivalent ion concentration of from  
25           about 50 ppm to about 200 ppm.

          3.    The binder composition of Claim 1, wherein the binder composition is insoluble in water having a multivalent ion concentration containing greater than about 200 ppm, and is  
30           soluble in water having a multivalent ion concentration of from about 100 ppm to about 200 ppm.

          4.    The binder composition of Claim 1, wherein the binder composition is insoluble in water having a multivalent ion concentration containing greater than about 200 ppm, and is  
35           soluble in water having a multivalent ion concentration of from about 150 ppm to about 200 ppm.

5           5. The binder composition of Claim 1, wherein the  
binder composition is insoluble in water having a monovalent ion  
concentration of greater than about 0.5 weight percent and is  
soluble in water having a monovalent ion concentration of less than  
about 0.3.

10

6. The binder composition of Claim 1, wherein the  
binder composition is insoluble in water having a temperature of  
from about 30 °C to about 37 °C, and is soluble in water having a  
temperature of from about 25 °C to about 20 °C.

15

7. The binder composition of Claim 1, wherein the  
binder composition is insoluble in water having a temperature of  
from about 32 °C to about 37 °C, and is soluble in water having a  
temperature of from about 25 °C to about 22 °C.

20

8. The binder composition of Claim 1, wherein the  
binder composition comprises from about 25 to about 99 weight  
percent of at least one ion-sensitive or temperature-sensitive  
polymeric material, and from about 75 to about 1 weight percent  
of at least one other polymer.

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9. The binder composition of Claim 1, wherein the at  
least one ion-sensitive or temperature-sensitive polymeric material  
comprises poly(vinyl alcohol), poly(vinyl methyl ether),  
30 hydroxypropyl cellulose, methyl hydroxypropyl cellulose, or a  
combination thereof.

30

10. A water-dispersible nonwoven fabric comprising fibers  
and the binder composition of Claim 1.

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5                   11. A water-dispersible nonwoven fabric comprising:  
                                fibers; and  
                                a temperature-sensitive or ion-sensitive binder  
composition comprising at least one temperature-sensitive or ion-  
sensitive polymeric material, wherein (a) the binder composition is  
10 insoluble in water having a monovalent ion concentration of greater  
than about 0.5 weight percent or a multivalent ion concentration  
containing greater than about 200 ppm, and is soluble in water  
having a monovalent ion concentration of less than about 0.5  
weight percent or a multivalent ion concentration containing less  
15 than about 200 ppm; or (b) the binder composition is insoluble in  
water having a temperature of greater than about 30 °C, and is  
soluble in water having a temperature of less than about 25 °C.

20                   12. The nonwoven fabric of Claim 11, wherein the binder  
composition is insoluble in water having a multivalent ion  
concentration greater than about 200 ppm multivalent ions, and is  
soluble in water having a multivalent ion concentration of from  
about 50 ppm to about 200 ppm.

25                   13. The nonwoven fabric of Claim 11, wherein the binder  
composition is insoluble in water having a multivalent ion  
concentration containing greater than about 200 ppm, and is  
soluble in water having a multivalent ion concentration of from  
about 100 ppm to about 200 ppm.

30                   14. The nonwoven fabric of Claim 11, wherein the binder  
composition is insoluble in water having a multivalent ion  
concentration containing greater than about 200 ppm, and is  
soluble in water having a multivalent ion concentration of from  
35 about 150 ppm to about 200 ppm.

5           15. The nonwoven fabric of Claim 11, wherein the binder composition is insoluble in water having a monovalent ion concentration of greater than about 0.5 weight percent and is soluble in water having a monovalent ion concentration of less than about 0.3.

10           16. The nonwoven fabric of Claim 11, wherein the binder composition is insoluble in water having a temperature of from about 30 °C to about 37 °C, and is soluble in water having a temperature of from about 25 °C to about 20 °C.

15           17. The nonwoven fabric of Claim 11, wherein the binder composition is insoluble in water having a temperature of from about 32 °C to about 37 °C, and is soluble in water having a temperature of from about 25 °C to about 22 °C.

20           18. The nonwoven fabric of Claim 11, wherein the binder composition comprises from about 25 to about 99 weight percent of at least one ion-sensitive or temperature-sensitive polymeric material, and from about 75 to about 1 weight percent of at least one other polymer.

25           19. The nonwoven fabric of Claim 11, wherein the at least one ion-sensitive or temperature-sensitive polymeric material comprises poly(vinyl alcohol), poly(vinyl methyl ether),  
30           hydroxypropyl cellulose, methyl hydroxypropyl cellulose, or a combination thereof.

35           20. A flushable personal care product comprising the water-dispersible nonwoven fabric of Claim 11.

5           21. A flushable personal care product comprising a water-dispersible nonwoven fabric, wherein the nonwoven fabric comprises:

                  fibers; and

                  a temperature-sensitive or ion-sensitive binder  
10       composition comprising at least one temperature-sensitive or ion-sensitive polymeric material, wherein (a) the binder composition is insoluble in water having a monovalent ion concentration of greater than about 0.5 weight percent or a multivalent ion concentration containing greater than about 200 ppm, and is soluble in water  
15       having a monovalent ion concentration of less than about 0.5 weight percent or a multivalent ion concentration containing less than about 200 ppm; or (b) the binder composition is insoluble in water having a temperature of greater than about 30 °C, and is soluble in water having a temperature of less than about 25 °C.

20           22. The flushable personal care product of Claim 21, wherein the binder composition is insoluble in water having a multivalent ion concentration greater than about 200 ppm multivalent ions, and is soluble in water having a multivalent ion  
25       concentration of from about 50 ppm to about 200 ppm.

          23. The flushable personal care product of Claim 21, wherein the binder composition is insoluble in water having a multivalent ion concentration containing greater than about 200  
30       ppm, and is soluble in water having a multivalent ion concentration of from about 100 ppm to about 200 ppm.

          24. The flushable personal care product of Claim 21, wherein the binder composition is insoluble in water having a multivalent ion concentration containing greater than about 200  
35       ppm, and is soluble in water having a multivalent ion concentration of from about 150 ppm to about 200 ppm.

5           25. The flushable personal care product of Claim 21,  
wherein the binder composition is insoluble in water having a  
monovalent ion concentration of greater than about 0.5 weight  
percent and is soluble in water having a monovalent ion  
concentration of less than about 0.3.

10

26. The flushable personal care product of Claim 21,  
wherein the binder composition is insoluble in water having a  
temperature of from about 30 °C to about 37 °C, and is soluble in  
water having a temperature of from about 25 °C to about 20 °C.

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27. The flushable personal care product of Claim 21,  
wherein the binder composition is insoluble in water having a  
temperature of from about 32 °C to about 37 °C, and is soluble in  
water having a temperature of from about 25 °C to about 22 °C.

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28. The flushable personal care product of Claim 21,  
wherein the binder composition comprises from about 25 to about  
99 weight percent of at least one ion-sensitive or temperature-  
sensitive polymeric material, and from about 75 to about 1 weight  
percent of at least one other polymer.

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29. The flushable personal care product of Claim 21,  
wherein the at least one ion-sensitive or temperature-sensitive  
polymeric material comprises poly(vinyl alcohol), poly(vinyl methyl  
ether), hydroxypropyl cellulose, methyl hydroxypropyl cellulose, or  
a combination thereof.

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30. The flushable personal care product of Claim 21,  
wherein the flushable personal care product comprises a wipe, a  
sanitary napkin, a diaper, a surgical dressing, or a tissue.

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